

2000 CALFED Science Conference

Session Notes

Effects of Nonnative Invasive Species

Session Chair: Kim Webb

Session Notetaker: Deborah Rudnick

Introduction: This session addressed non-native, invasive species in the Bay and Delta ecosystem. Throughout the session, speakers often referred to the fact that the San Francisco Bay and Delta ecosystem, with over 230 known non-native organisms, is one of the most invaded ecosystems in the world, highlighting the importance of prevention and research into the vast changes being affected by invasive species in this system. Speakers addressed a wide variety of taxa that have been recently introduced to this ecosystem, including plants, zooplankton, clams, and crustacea. Talks covered aspects of these organisms ranging from population dynamics to effects on community composition, food web alterations and impacts on restoration efforts.

Community Effects of the Non-Indigenous Aquatic Plant Water Hyacinth (Eichhornia crassipes) in the Sacramento/San Joaquin Delta - Jason Toft, University of Washington

This study was initiated as part of a CALFED BREACH study to examine restored wetlands. The goal of this study was to quantify effects of a non-native species on community composition by comparing its role in the system to that of a similar, native species. Insect and fish communities associated with the nonnative Hyacinth (*Eichhornia crassipes*) were compared to those utilizing the native pennywort (*Hydrocotyle umbellata*) in shallow habitats in the Delta.

Hyacinth is known to have deleterious ecological and economic effects in the Delta. Introduced through its use in ornamental ponds, Hyacinth has escaped into the Delta where it outcompetes natives, blocks waterways, shades aquatic habitat and creates low dissolved oxygen levels in its vicinity. The structure of this plant is fundamentally different from that of Pennywort: Hyacinth's roots are bushy while those of Pennywort are stringy and less dense; in turn, Pennywort has a higher leaf density than that of Hyacinth. These structural differences provided the basis for questioning whether this non-native species would play a different role from its native counterparts in the aquatic communities of the Delta.

According to research results, the taxonomic assemblages of the two plants are also strikingly different. Inter-site variation was an important complicating factor in assessment of differences between plants. However, many trends were evident, including an association of the non-native amphipod *Crangonyx floridanus* with Hyacinth versus a much higher proportion on the native amphipod *Hyallela*

azteca with Pennywort. Mr. Toft showed that *Crangonyx*, as a smaller amphipod, was more able to take advantage of the Hyacinth root structure and therefore obtain better refuge. In addition, his amphipod is lower in caloric value and less palatable to fish than the native *Hyalloa*. The study suggests that in this case, a non-native plant can facilitate success of a fellow non-native. This study also had the valuable outcome of discovering and identifying three new non-native amphipod species.

Changes in Mysid and Zooplankton Species Composition and Abundance in the Upper San Francisco Estuary - James Orsi, DF&G.

California's Department of Fish and Game has an impressive data set extending back to 1968 for mysids and to 1972 for zooplankton in San Francisco Bay. The data also contains information on temperature, conductivity, turbidity and chlorophyll for this entire period, making possible physical and chemical associations with the taxonomic data. Mr. Orsi examined the species composition, abundance, and distribution of these taxa from this data set.

During the past thirty years, eight copepod species and four species of mysid shrimp have been introduced into San Francisco Bay. The population trajectories of these species have been complicated: some species have remained abundant, while others have fluctuated between abundance and decline. Importantly, all species were first collected in three main time periods: 1978-1979, 1986-1987, and 1992-1993. These waves of introduction correspond closely to periods of drought in 1976-1977, and again in 1987-1992, suggesting that low water years may in some way contribute to establishment of these non-natives. While non-native copepods have increased in abundance, native copepods have become extremely rare in San Francisco Bay. There appears to be a shift from a Calanoid-dominated system to one with more Cyclopoids, which are more predatory and thus could contribute to food web alterations. Mr. Orsi concluded by mentioning the passage of California AB 703 that mandates open-open exchange to reduce the potential for ships to transport non-native species between coastal ecosystems, as providing hope for slowing down rates of introduction of invasive aquatic species.

All copepods are not Created Equal: Effects of the Clam Potamocorbula amurensis on Estuarine Foodwebs - Wim Kimmerer, SFSU Romberg Tiburon Center.

In this talk, Dr. Kimmerer explored the role of declines in productivity at the base of the Bay and Delta estuarine foodweb in the decline of fish abundance in recent decades. Dr. Kimmerer hypothesized that the invasive clam *Potamocorbula amurensis* has played a role in reducing productivity in this food web, thus reducing availability of resources to fish. This hypothesis set the framework for

his research into the mechanisms of simultaneous decline of chlorophyll concentrations and of a numerically dominant copepod, *Acartia* sp.

Dr. Kimmerer set up a series of laboratory experiments to test the predation avoidance mechanisms of copepods with respect to the filtration efforts of *P. amurensis*. The results indicated that the copepods had good response mechanisms to avoid ingestion by the clam, suggesting that direct ingestion was not causing decline of copepods. Instead, it is suggested that *Acartia* reproduction can be strongly food-limited, so that removal of chlorophyll by *P. amurensis* may be driving the decline in this copepod species. Important questions that follow from this research include the stratification of *P. amurensis* food items, and the toxicological effects on these trophic shifts on copepods.

Diet Shift in Fishes of the Sacramento-San Joaquin Estuary following the invasion of Potamocorbula amurensis - Frederick Feyrer, DWR.

The introduction of the Asian clam *Potamocorbula amurensis* has been implicated in many trophic effects, including dramatic declines in phytoplankton and many native estuarine invertebrates. To examine these trophic effects, Mr. Feyrer and his colleague Scott Matern examined the food habits of five resident fishes of Suisun Marsh - splittail *Pogonichthys macrolepidotus*, tule perch *Hysterothorax traski*, prickly sculpin *Cottus asper*, yellowfin goby *Acanthogobius flavimanus* and striped bass *Morone saxatilis*- from March 1998 through January of 1999. They compared the results of this study to those of a similar study completed in 1983, prior to the invasion of *P. amurensis*.

Fish diets were found to be similar between the two periods, but the dietary importance of mysid shrimp (*Neomysis mercedis*) declined more than six-fold between the two time periods, leading to near elimination of the shrimp from all species diet. However, it appears that these fish successfully exploited alternative prey, because feeding incidence, stomach fullness and body condition appeared similar in the two periods of study. Although Mr. Feyrer cautioned that the results were based only on two years of evidence, it does appear that other measures of population health of these fish, including fecundity and average size, have declined in the period since introduction of the clam.

Reciprocal Hybridization of Threat of Invasive Spartina to Salt Marshes in the San Francisco Estuary - Debra Ayres, UC Davis

Spartina alterniflora has been dubbed an "ecosystem engineer" for its ability to create significant hydrologic and landscape changes through accretion of sediment, water flow impediment, and elimination of open mudflat habitat important to shorebirds. While the native cordgrass in San Francisco Bay, *Spartina foliosa*, is 1/2m to 1m in height and grows somewhat sparsely, *S. alterniflora* grows in dense clusters up to 3m tall, and spreads laterally more quickly than the native. This estuarine plant species was introduced into South

San Francisco Bay from the eastern U.S. about 25 years ago, and has spread throughout several areas in the South and North Bay and Delta. However, according to Dr. Ayres, its potential range of spread is much larger than its current distribution. The ability of this plant to hybridize with the native cordgrass may be particularly problematic: her research has identified extensive areas of hybrids in the Bay and Delta system.

Dr. Ayres studied the characteristics of hybrids of the two species in an attempt to characterize rates of hybridization and effects on plant morphology and reproduction. Using RAPD, her research team developed a suite of markers to create a hybrid index from 0% to 100% *S. alterniflora*. Dr. Ayres reported a positive correlation between increasing contribution of the *S. alterniflora* genome and plant size, spikelet number, pollen abundance and viability, and seedling growth, offsetting a lower seed set and germination rate for the hybrids. In the field, little temporal overlap in flowering was found between the two species, and no F1 hybrids were found. *S. alterniflora/foliosa* hybrids effectively bridge the phenological gap by flowering at a period intermediate to the two species. The robust hybrids of these species, Dr. Ayres suggested, are creating an even greater menace to the Bay/Delta ecosystem than its non-native parent, and could lead to the extinction of *S. foliosa*.

Invasive Plant Dynamics in Marshes following Tidal Enhancement - Laura Hanson, Contra Costa Mosquito and Vector Control District.

Diking has caused many ecosystem problems, including subsidence, poor circulation and poor drainage throughout the marsh ecosystem. At Point Edith marsh, a restoration project was paired with monitoring efforts, including aerial mapping before and after restoration and comparison of control and treatment (restored) wetlands. Ms. Hanson explored the effects of restoration activity on changes in abundance and distribution of the non-native invasive shrub *Lepidium latifolium*, the invasive plant *Phragmites* that first appeared in the system during restoration, and invasive *Typha* spp. The study period coincided with a period of drought and its associated higher salinity and shorter flood events, and El Nino, bringing wet winters; these events allowed for an examination of population dynamics of the non-native with respect to climatic changes.

L. latifolium did not appear to be affected by tidal restoration, as control and treatment sites both showed similar trends in distribution and abundance. However, in both sites, *L. latifolium* declined in abundance; Ms. Hanson suggested that the infection of this plant by the parasitic plant Canyon Daughter reduced the abundance of *L. latifolium*. *Typha*, by contrast, dramatically increased in the restored site to twice its abundance at the control site, largely replacing the native *Salicornia*. Remaining *Salicornia* has altered its morphology to grow tall and spindly in the presence of the tall *Typha* to compete for sunlight.

In conclusion, Ms. Hanson emphasized the importance of climatic variability in restoring tidal wetlands. Restoration may not have the expected results; in this case, it increased one invasive species (*Typha*) while not affecting another (*Lepidium*). It is important to monitor several species over different seasons, and also to monitor over longer periods of time to incorporate climatic variables.

The Potential Impacts of the European Green Crab on Estuarine Restoration -
Edwin Grosholz, UC Davis

Dr. Grosholz presented research on the effects of the green crab *Carcinus maenus* on benthic estuarine ecosystems. He presented this research in the context of considering the effects of non-native species in ecosystem restoration. As the Bay and Delta has lost over 90% of its estuarine habitats, and as remaining habitats are threatened by development, preservation and restoration of mudflat/wetland habitat becomes increasingly important. Effects of invasive species in the Bay and Delta complicate the restoration process.

The green crab was accidentally introduced to San Francisco Bay around 1989/1990. Green crabs have been documented in their native and introduced habitats to cause dramatic impacts on native species. Dr. Grosholz's research in Bodega Bay also shows destructive impacts by the green crab on the estuarine ecosystem, including 90-95% reductions in small bivalves and shore crabs upon which the green crab preys. The green crab occupies a unique niche as a particularly large and voracious predator that can eat organisms as large as juvenile Dungeness crabs. The depletion of native invertebrate species may have detrimental effects for wintering shorebirds in San Francisco Bay. Green crabs may also directly interfere with restoration by damaging outplanted seagrasses used in restoration.

Dr. Grosholz concluded by pointing out that we will inevitably continue to see invasions by non-native species into the Bay and Delta ecosystem. Managing for these invasions in a species-specific and reactive manner is not an effective or cost-efficient approach. Restoration must tip the balance towards native species. Dr. Grosholz concluded the session with a call to action: CALFED is in an excellent position to take a pro-active approach by establishing funds for education, outreach and prevention of the introduction of invasive species into the Bay and Delta.